

SunRui BalClor™ BWMS

Land-base Test for Using Boll Filter

Test Report

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2013-1

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1. Introduction

SunRui Marine Environment Engineering Co., Ltd has developed BalClor™ ballast water management system (BalClor™ BWMS), on the basis of the electrolysis seawater treatment technology. BalClor™ BWMS has met the international maritime organization (IMO) requirements on ballast water treatment, and treatment effect fulfills the Regulation D-2 of IMO BWM Convention.

Final Approval of the BWMS was granted to BalClor™ BWMS in October 2010 at MEPC 61. The type approval certification for China Classification Society (Certification No.QD09T00031_02) was granted to BalClor™ BWMS on January 28, 2011. The type approval certification of DNV (Certification No. P-14030) was granted to BalClor™ BWMS on August 6, 2012.

The purpose of this test was to demonstrate the biological efficacy of the BalClor™ BWMS using Boll & KIRCH filter. There were two test cycles in this land-base test, including one high salinity (>32PSU) and one medium salinity (3-32PSU,). Salinity between two test cycles was separated by at least 10 PSU. All test process was witnessed by DNV surveyor from 2012-12-27 to 2013-1-11. Test cycle 01 date was from 2012-12-27 to 2013-1-1. Test cycle 02 dates was from 2013-1-6 to 2013-1-11. Each land-based test cycle tests included biological efficacy analysis and seawater parameters test of two salinity range.

2. Land-based test setup and BalClor™ BWMS

2.1 Land-based set-up

The land-based testing facility with flow rate of 250m³/h was established in Qingdao in accordance with the IMO Guidelines (G8 Guidelines for Approval of Ballast Water Management Systems) (See Figure 2-1 and Figure 2-2). Preparation, installation and debugging of test facility were accomplished by SunRui Marine Environment Engineering Co., Ltd. Based on the testing and research work; the basic operational parameters of the BalClor™ BWMS have been defined.

There are four simulated tanks in total, each with a volume of 250m³. Two tanks

(Culture tanks) are used for preparing the influent water to be tested. The other two tanks are used as holding tanks, one (Treated ballast tank) for storing treated water, and one (Control ballast tank) for keeping control water.

The land-based set-up for two test cycles was as the same that the setup was witnessed by DNV before.

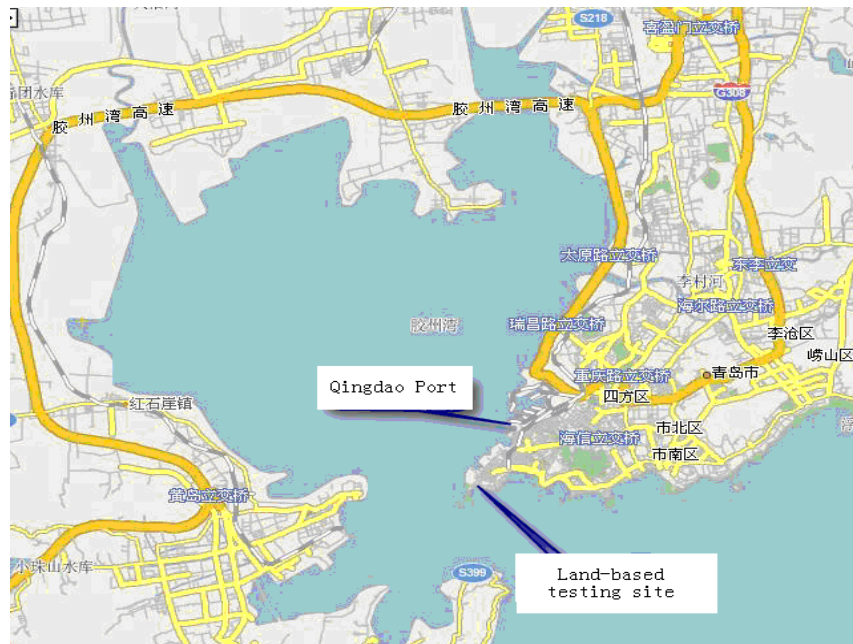


Figure 2-1 The location of land-based testing site



Figure 2-2 Land-based set-up (QINGDAO)

2.2 BalClor™ BWMS configuration

The test model of BalClor™ BWMS is BC-300, its treatment capacity range is 100~400 m³/h, and the tests were performed at the flow rate of 200~300m³/h. The TRO concentration for treatment will be pre-set at 7.5mg/L. Self-cleaning filter was Boll & KIRCH filter (type 6.18.2 DN200 GR.250).



Figure 2-3 Boll & KIRCH filter (type 6.18.2 DN200 GR.250)

3. Results of seawater parameters test and biological efficacy analysis

3.1 Test cycle 01

3.1.1 Results of sea water parameters

The results of seawater parameters of test cycle 01 were listed in Table 3-1.

3.1.2 Results of viable organisms analysis

The results of viable organisms analysis of test cycle 01 were listed in Table 3-2.

The influent water 20121227-TC01T-INF consists of 8 species of viable organisms greater than or equal to 50 μm in minimum dimension from 4 different phyla/divisions and 7 species of viable organisms greater than or equal to 10 μm and

less than 50 μ m in minimum dimension from 4 different phyla/divisions; The influent water 20121227-TC01C-INF consists of 8 species of viable organisms greater than or equal to 50 μ m in minimum dimension from 4 different phyla/divisions, and 7 species of viable organisms greater than or equal to 10 μ m and less than 50 μ m in minimum dimension from 4 different phyla/divisions.

3.1.3 Results of viable bacteria analysis

The results of viable bacteria analysis of test cycle01 were listed in Table 3-3.

3.1.4 Conclusion

In test cycle 01, the test results showed that the performance of the influent water, treated water and control water met the requirements of G8.

Table 3-1 Results of environmental parameter measurement of test cycle 01

Items	Unit	Lot No.						
		20121227- TC01T-INF-EP	20121227- TC01T-IAT-EP	20121227- TC01C-INF-EP	20121228- TC01T-24h-EP	20121228- TC01C-24h-EP	20130101- TC01T-120h-EP	20130101- TC01C-120h-EP
Temperature	℃	4.5	4.5	4.5	5.0	5.0	2.5	2.6
Salinity	PSU	33.1	33.1	33.1	33.2	33.2	33.1	33.1
TSS	mg/L	4.92	3.43	4.09	3.86	3.66	3.81	3.49
Dissolved Oxygen	mg/L	12.00	13.38	12.04	12.57	11.63	10.65	11.36
pH		7.93	8.00	7.94	7.93	7.91	7.72	7.75
Turbidity	°	4.07	3.39	3.99	3.39	2.67	3.54	2.04
DOC	mg/L	2.44	2.72	2.55	2.68	2.52	2.28	1.64
POC	mg/L	1.88	1.15	1.23	1.27	1.36	1.52	1.12

Table 3-2 Results of viable organisms analysis of test cycle 01

Viable Organisms	Lot No.									
	20121227- TC01T-INF	20121227- TC01T-INF --Rec	20121227- TC01T-IAT	20121227- TC01C-INF	20121227- TC01C-INF --Rec	20121228- TC01T-24h	20121228- TC01C-24h	20130101- TC01T-120h	20130101- TC01T-120h	20130101- TC01C-120h
greater than or equal to 50µm in minimum dimension, individuals per cubic meter	1.10×10^5	—	1.67	1.10×10^5	—	2.55	560.00	2.33	—	413.33
greater than or equal to 10µm and less than 50µm in minimum dimension, individuals per milliliter	1043.52	1107.33	18.90	1042.62	1132.81	2.50	326.92	0	0	111.89

Table 3-3 Results of the viable bacteria analysis of test cycle 01

Lot No.	Test Item			
	Heterotrophic bacteria (CFU/mL)	<i>Escherichia coli</i> (CFU/100mL)	Intestinal <i>Enterococci</i> (CFU/100mL)	<i>Vibrio cholerae</i> (serotypes O1 and O139) (CFU/100mL)
20121227- TC01T-INF-BAC	2.60×10^4	4.00×10^2	0.37×10^2	8.67×10^2
20121227- TC01T-IAT- BAC	0	0	0	0
20121227- TC01C-INF- BAC	2.51×10^4	5.07×10^2	0.43×10^2	1.98×10^3
20121228- TC01T-24h- BAC	0	0	0	0
20121228- TC01C-24h- BAC	2.38×10^4	4.87×10^2	0.36×10^2	3.72×10^3
20130101- TC01T-120h- BAC	0	0	0	0
20130101- TC01C-120h- BAC	9.11×10^3	8.53×10^2	1.66×10^2	5.00×10^2

3.2 Test cycle 02

3.2.1 Results of sea water parameters

The results of seawater parameters of test cycle 02 were listed in Table 3-4

3.2.2 Results of viable organisms analysis

The results of viable organisms analysis of test cycle 02 were listed in Table 3-5

The influent water 20130106-TC01T-INF consists of 8 species of viable organisms greater than or equal to 50 μ m in minimum dimension from 4 different phyla/divisions and 8 species of viable organisms greater than or equal to 10 μ m and less than 50 μ m in minimum dimension from 3 different phyla/divisions; The influent water 20130106-TC01C –INF consists of 9 species of viable organisms greater than or equal to 50 μ m in minimum dimension from 4 different phyla/divisions, and 9 species of viable organisms greater than or equal to 10 μ m and less than 50 μ m in minimum dimension from 3 different phyla/divisions.

3.1.3 Results of viable bacteria analysis

The results of viable bacteria analysis of test cycle 02 were listed in Table 3-6.

3.1.4 Conclusion

In test cycle 02, the test results showed that the performance of the influent water, treated water and control water met the requirements of G8.

Table 3-4 Results of environmental parameter measurement of test cycle 02

Items	Unit	Lot No.						
		20130106- TC02T-INF-EP	20130106- TC02T-IAT-EP	20130106- TC02C-INF-EP	20130107- TC02T-24h-EP	20130107- TC02C-24h-EP	20130111- TC02T-120h-EP	20130111- TC02C-120h-EP
Temperature	℃	1.8	2.0	1.8	2.4	2.6	3.4	3.6
Salinity	PSU	21.5	21.5	21.5	21.5	21.6	21.5	21.5
TSS	mg/L	67.62	36.28	64.28	31.14	60.10	15.58	18.22
Dissolved Oxygen	mg/L	12.08	13.56	12.10	13.30	12.23	11.47	12.24
pH		7.88	7.95	7.84	7.91	7.85	7.65	7.81
Turbidity	°	15.37	9.25	15.56	9.20	12.68	8.93	10.45
DOC	mg/L	6.95	6.90	6.95	6.94	7.01	5.25	5.22
POC	mg/L	5.33	5.48	5.84	5.43	6.07	4.08	4.01

Table 3-5 Results of viable organisms analysis of test cycle 02

Viable Organisms	Lot No.								
	20130106- TC02T-INF	20130106- TC02T-IAT	20130106- TC02C-INF	20130106- TC02C-INF -Rec	20130107- TC02T-24h	20130107- TC02C-24h	20130111- TC02T-120h	20130111- TC02C-120h	20130111- TC02C-120h -Rec
greater than or equal to 50µm in minimum dimension, individuals per cubic meter	1.93×10 ⁵	0	1.93×10 ⁵	—	0	763.33	0.33	441.11	—
greater than or equal to 10µm and less than 50µm in minimum dimension, individuals per milliliter	2386.83	14.96	2407.51	2527.47	2.60	1184.63	0	308.83	330.77

Table 3-6 Results of the viable bacteria analysis of test cycle 02

Lot No.	Test Item			
	Heterotrophic bacteria (CFU/mL)	<i>Escherichia coli</i> (CFU/100mL)	Intestinal <i>Enterococci</i> (CFU/100mL)	<i>Vibrio cholerae</i> (serotypes O1 and O139) (CFU/100mL)
20130106- TC02T-INF-BAC	2.02×10 ⁴	2.55×10 ³	8.71×10 ²	8.29×10 ³
20130106- TC02T-IAT- BAC	0	0	0	0
20130106- TC02C-INF- BAC	2.00×10 ⁴	4.07×10 ³	1.09×10 ³	7.37×10 ³
20130107- TC02T-24h- BAC	0	0	0	0
20130107- TC02C-24h- BAC	1.87×10 ⁴	3.23×10 ³	9.81×10 ²	5.55×10 ³
20130111- TC02T-120h- BAC	0	0	0	0
20130111- TC02C-120h- BAC	2.23×10 ⁴	2.31×10 ³	8.16×10 ²	5.39×10 ³

4. Record of parameters of filter

4.1 Test cycle 01

The pressure of inlet and outlet filter for test cycle 01 was listed in Table 4-1.

Table 4-1 Pressure of inlet and outlet filter for test cycle 01

Time(min)	20	30	40	50	60
Pressure of inlet filter (bar)	2.8	2.9	2.8	2.8	2.7
Pressure of outlet filter (bar)	2.2	2.3	2.2	2.2	2.1

The flow rates through the filter for test cycle 01 were listed in Table 4-2.

Table 4-2-Flow rates through the filter for test cycle 01

Time(min)	0	10	20	30	40	50	60	70
Flow rates through the filter (m ³ /h)	206	210	209	205	210	203	210	208

Number of back-flushes on the filter during test cycle 01 was 5 times.

Energy consumption of filter was 0.09KW.

4.2 Test cycle 02

The pressure of inlet and outlet filter for test cycle 02 was listed in Table 4-3.

Table 4-3 Pressure of inlet and outlet filter for test cycle 02

Time(min)	20	30	40	50	60
Pressure of inlet filter (bar)	2.8	2.8	2.7	2.7	2.65
Pressure of outlet filter (bar)	2.18	2.05	1.83	2.1	2.0

The flow rates through the filter for test cycle 02 were listed in Table 4-4.

Table 4-4 Flow rates through the filter for test cycle 02

Time(min)	0	10	20	30	40	50	60
Flow rates through the filter (m ³ /h)	224	221	219	212	214	217	210

Number of back-flushes on the filter during test cycle 01 was 6 times.

Energy consumption of filter was 0.09KW.

5. Record of parameters of electrolysis unit

5.1 Test cycle 01

TRO concentration measured during ballasting and de-ballasting for test cycle 01 was separately listed Table 5-1 and Table 5-2.

Table 5-1 TRO concentration of treated tank during ballasting of TC01

Time(min)	0	10	20	30	40	50	60	70
TRO concentration during ballasting(mg/L)	7.47	7.46	7.46	7.48	8.45	7.58	7.51	7.52

Table 5-2 TRO concentration of treated tank during de-ballasting of TC01

Time(min)	10	20	30	40	50	60
TRO concentration during de-ballasting (mg/L)	0.00	0.00	0.06	0.04	0.01	0.01

Electrolytic current, voltage of electrolyzers and flow rate to electrolyzers for test cycle 01 were listed in Table 5-3.

Table 5-3 Records of operational parameters of BalClor™ BWMS of TC01

Time	Electrolytic current (A)	Voltage of electrolyzers (V)	Flow rate to electrolyzers (m ³ /h)
0min	126	74	6.1
10min	126	74	5.8
20min	126	74	5.8
30min	126	74	5.6
40min	137	82	6.1
50min	136	81	5.9
60min	130	77	5.8
70min	130	77	5.9

Eventual dosage of neutralizer was 16.25L.

5.2 Test cycle 02

TRO measured during ballasting and TRO during de-ballasting for test cycle 02 was separately listed Table 5-4 and Table 5-5.

Table 5-4 TRO concentration of treated tank during ballasting of TC02

Time(min)	0	10	20	30	40	50	60
TRO concentration during ballasting (mg/L)	6.58	6.89	7.32	7.35	7.54	7.85	7.42

Table 5-5 TRO concentration of treated tank during de-ballasting of TC02

Time(min)	10	20	30	40	50	60
TRO concentration during de-ballasting (mg/L)	0.00	0.00	0.00	0.00	0.00	0.00

Electrolytic current, voltage of electrolyzers and flow rate to electrolyzers for test cycle 02 were listed in Table 5-6.

Table 5-6 Records of operational parameters of BalClor™ BWMS of TC02

Time	Electrolytic current (A)	Voltage of electrolyzers (V)	Flow rate to electrolyzers (m ³ /h)
0min	132	87	5.6
10min	148	88	5.7
20min	156	93	5.4
30min	148	88	5.4
40min	145	88	5.5
50min	149	90	5.8
60min	154	90	5.4

Eventual dosage of neutralizer was 15L.